3.0 AFFECTED ENVIRONMENT

3.1 Climate

The subtropical climate of south Florida, with its distinct wet and dry seasons, high rate of evapotranspiration, and climatic extremes of floods, droughts, and hurricanes, represents a major physical driving force that sustains the Everglades while creating water supply and flood control issues in the agricultural and urban segments.

Seasonal rainfall patterns in south Florida resemble the wet and dry season patterns of the humid tropics more than the winter and summer patterns of temperate latitudes. Of the 53 inches of rain that south Florida receives on average annually, 75% falls during the wet season months of May through October. During the wet season, thunderstorms that result

unit. The discontinuous and locally productive water bearing units of the surficial aquifer include the Biscayne Aquifer, the undifferentiated surficial aquifer, the coastal aquifer of Palm Beach and Martin Counties, and the shallow aquifer of south Florida. Practically all municipal and irrigation water is obtained from the intermediate aquifer system. The intermediate aquifer system consists of beds of sand, sandy limestone, limestone, and dolostone that dip and thicken to the south and southwest. In much of south Florida, the intermediate aquifer system represents a confining unit that separates the surficial aquifer system from the Floridan aquifer system. The Floridan aquifer system is divided by a middle confining unit into the Upper and Lower Floridan aquifers. In the lower east coast, the Upper Floridan aquifer is being considered for storage of potable water in an aquifer storage and recovery program. In the Lower Floridan aquifer, there are zones of cavernous limestones and dolostones with high transmissivities. However, because these zones contain saline water, they are not used as a drinking water supply and are used primarily for injection of treated effluent wastewater.

3.3 Hydrology

The primary source of water for the ENP comes from direct rainfall and accounts for approximately 70 % of the total influx. The remaining 30% enters the ENP in the form of surface flow. Since 1985, the water delivery management schedule for ENP has followed the Rainfall Plan. The operational target for the managed deliveries under the Rainfall Plan is 45% delivered to Western Shark River Slough (WSRS) (via the S-12 structures) and 55 % delivered to NESRS (via S-333, S-355A, and S-355B). The Rainfall Plan bases the amount and timing of water deliveries to SRS on recent rainfall and evapotranspiration to the north in WCA 3A. Weekly adjustments are made to delivery rates based on the previous week's flow rate and the rainfall and evapotranspiration data from the previous ten weeks. In addition to the Rainfall Plan component, a supplemental stage component is added based on the degree to which average water levels in WCA 3A exceed the regulation schedule. Under normal or dry conditions, this stage component is zero.

To describe the hydrology of the ENP, it is necessary to discuss two of the criteria that are used to evaluate the model runs, hydroperiod distribution and ponding depth. These are outputs from simulation runs for a 31-year period, 1965 to 1995 (Appendix H). The hydroperiod distribution is presented as classes of inundation in days. There are seven classes ranging from 0 to 60 days (dry) to 300 to 365 days (wet). Ponding depths are also used. These are depths above the ground surface and there are six classes ranging from 0.0 to 0.1 feet (dry) to 2.0 to 3.0 feet (wet). The maximum range of inundation in the ENP is aligned along an axis beginning at the northeast corner and extending southwestward through the Park. This axis

ground elevations), including parts of the 8.5 SMA and Rocky Glades. To the west near the Big Cypress National Preserve, the inundation class is 60 to 180 days, with inundation for some of the cells increasing to 180 to 240 days along the fringe of the low trough through the center of the Park. Within the 31-year simulation period there are wet and dry years. The year 1995 is presented as a wet year and 1989 is presented as a dry year. For a wet year, the maximum inundation class is 330 to 365 days and covers the entire ENP with the exception of a small area of high ground in the Taylor Slough area adjacent to L-31N and L-31W. For a dry year (1989), the inundation is much less. Along the low trough aligned northeast to southwest the class of inundation decreases to 180 to 300 days. In the eastern area the inundation is 0 to 120 days over the majority of the area. For the high ground, the inundation is in the minimum class (0 to 60 days).

Annual average ponding depth ranges from 0.0 to 0.1 foot in the southeastern portion of the ENP along the L-31N and L-31W canals, and in the Rocky Glades and Taylor Slough areas to depths of 0.5 to 1.0 foot in the center along the northeast to southwest trough and NESRS. The western area is primarily 0.1 to 0.5 foot in ponding depth, with 0.5 to 1.0 foot on the western edge of the low trough and along the west side of L-67 Extension Canal. Simulation runs for an average October, which would represent a wet month, shows deeper depth in all areas, as should be expected. The increment of increase is about 1.0 foot. Simulation runs for an average May, representing a dry month shows a much drier scenario throughout the Park. For the wet trough through the center of the ENP, the ponding depth decreases from 1.0 to 2.0 feet to 0.1 to 0.5 foot for the dry month (May). Although there is a decrease in almost all other areas of the ENP, these decreases are not as dramatic as those in the wet trough.

Specific areas within the project boundaries have distinct hydrologic conditions that could be affected by changes in the water management schedule. These areas are addressed in the ensuing text.

Northeast Shark River Slough (NESRS). NESRS is a complex area located in the northeast corner of the ENP. It is currently the northern terminus of Shark River Slough, which is aligned from the northeast to southwest across the ENP. Tamiami Trail is the northern boundary, the L-31N Canal the eastern boundary, and the L-67 Extension Canal the western boundary of the area. Historically, the area would be characterized as wet the majority of the year, but regional developments have impacted fresh water routes into the area and the dry seasons can significantly reduce surface waters.

Current objectives are to increase the amount of water entering NESRS (being addressed by the MWD project). Water enters NESRS primarily from WCA 3A via S-333 to the L-29 borrow canal and subsequent passage through culverts under Tamiami Trail. In addition, S-355A, S-355B, and G-69 may also be used to deliver water from WCA 3B to the L-29 canal for subsequent passage through the culverts to NESRS. The current operational target for managed deliveries to SRS is 45 % of the regulatory flows delivered to WSRS (via the S-12 structures) and 55 % delivered to NESRS (via S-333, S-355A, and S-355B). Eastern portions of the ENP are also influenced by the system of canals and structures that provide flood control and water supply for the LEC urban and agricultural areas. Efforts to provide flood control for the Lower East Coast (LEC) have apparently resulted in over-drying and adverse

ecological effects in eastern portions of the ENP (USACE 1999a). Over-drainage in the peripheral wetlands along the eastern flank of NESRS has resulted in shifts in community composition, invasion by exotic woody species, and increased susceptibility to fire (USFWS 1999a,b).

The NESRS is an important area with regards to water delivery, but it is a complex area. The average annual number of days of inundation in NESRS ranges from 1 to 60 days, to 240 to 300 days immediately adjacent to L-31N Canal, and to 330 to 365 days toward the west near the L-67 Extension Canal. In a dry year, the range is from 0 to 60 days to 240 to 300 days. In a wet year, such as 1995, the hydroperiod is in the maximum of 300 to 365 days of inundation per year. There is a significant difference between a dry year and a wet year. Average ponding depths generally range from 0.5 to 1.5 feet. For a wet year, depths are about twice the average. For a dry year, depths average from 0.5 to 1.0 foot.

Western Shark River Slough (WSRS). This area, located to the west of L-67 Extension Canal and bounded on the north by the Tamiami Trail, is primarily influenced by operation of the S-12 structures (A, B, C and D). The structures are staggered in operation from west to east in an effort to continue to move some water into SRS but keep it as far east of CSSS subpopulation A as possible. Beginning with structure S-12A it would discharge 10 % of the target flows; S-12B would discharge 20%; S-12C would discharge 30%; and S-12D would discharge 40%. The current overall operational target for managed deliveries to SRS is 45% delivered to WSRS (via the S-12 structures) and 55% delivered to NESRS (via S-333, S-355A, and S-355B). The actual percentage may vary for each regulatory release event.

The average hydroperiod for this area is characterized by days of inundation ranging from 120 to 330 days. The average would be about 240 days. For a wet year such as 1995, the area is inundated 330 to 365 days. A dry year is greatly different. The days of inundation per year range from 60 to as many as 300 but the average would be closer to about 200 days. Average ponding depth ranges from 0.5 to 1.0 feet.

Water Conservation Area 1. (WCA1). WCA1 (Loxahatchee National Wildlife Refuge) is about 21 miles long from north to south [redacted]

Water Conservation Areas 2A, 2B (WCA 2A, 2B). WCA 2 is comprised of two areas, 2A and 2B, measures about 25 miles from north to south, and covers an area of 210 square miles. It is separated from the other WCAs by the Hillsborough Canal on the north and the North New River Canal on the south. Ground elevations slope southward about two to three feet in 10 miles, ranging from over 13 feet NGVD in the northwest to less than 7 feet NGVD in the south. The area is enclosed by about 61 miles of levee, of which approximately 13 miles are common to WCA1 and 15 miles to WCA3. An interior levee across the southern portion of the area reduces water losses due to seepage into an extremely pervious aquifer at the southern end of the pool and prevents overtopping of the southern exterior levee by hurricane waves.

Water is passed from this area to WCA 3A via the S-11 structures. In a wet year the entire area is in the 330 to 365 days per year inundation. In a dry year the area is significantly drier with a range of inundation going from 60 to 120 days in the north to 240 to 300 days inundation in the south. The lower end of this area is characterized as wet.

The upper pool, WCA2A, provides a 173 square mile reservoir for storage of excess water from WCA1 and a 125 square mile agricultural drainage area of the North New River Canal. Storage in WCA2A provides water supply to the east coast urban areas of Broward County. Water enters the area from WCA1 and the Hillsborough Canal on the northeast side, and from the North New River Canal on the northwest side. Water in excess of that required for efficient operation of WCA2A is discharged to WCA3 via structures into C-14, the North New River Canal, and WCA2B.

WCA2B has ground elevations ranging from 9.5 feet NGVD in the northern portions down to 7 feet NGVD in the southern portions of the area. The area experiences a high seepage rate, which does not allow for the long-term storage of water, and as a result, water is not normally released from the area.

Water Conservation Areas 3A, 3B (WCA 3A, 3B). WCA3 is divided into two parts, 3A and 3B. It is about 40 miles long from north to south and comprises about 915 square miles, making it the largest of the water conservation areas. Ground elevations, which slope [redacted]

salinity control requirements for Dade and Monroe Counties, irrigation requirements, and water supply for ENP.

These areas are located immediately north of the Tamiami Trail and east of the L-30 Canal. The L-67 A and C Canals at Tamiami Trail represents the dividing point between WCA 3A and WCA 3B. WCA 3A is the primary source of water deliveries to the ENP across Tamiami Trail to WSRS through the S-12 Structures and to NESRS via S-333 to the L-29 borrow canal for subsequent passage through culverts under Tamiami Trail and/or discharge to the L-31N Canal via Structure S-334. In addition, S-355A, S-355B, and G-69 may also be used to deliver water from WCA 3B to the L-29 canal for subsequent passage through the culverts to NESRS; however, water cannot be discharged from 355A and 355B when the L-29 stage is above the WCA 3B stage. Simulation runs for existing conditions indicate that WCA 3A is very wet for the majority of the area (±90%). For a wet year, the percentage goes to 100%. For a dry year, there is a wide range of inundation ranging from 60 to 120 days in the north to 330 to 365 days in the southern half and along the eastern border. Conditions in WCA 3B are very similar to conditions just described for WCA 3A. The eastern edge of this conservation area is probably a little drier on average than conditions in the southeastern part of 3A.

Taylor Slough. Taylor Slough is in the southeast quadrant of the ENP. The area through the Rocky Glades and Taylor Slough is a foot or more higher in elevation compared to ground levels north and south or west toward the low trough. Because of this characteristic, the area is normally drier than other areas in the ENP. In a dry year, the hydroperiod is in the lowest class of inundation (0 to 60 days) and ponding depths are 0.0 to 0.1, which is, for all practical purposes, 0. The area is somewhat like an island or a peninsula extending out from the canals into the ENP. Parts of this area have been affected by over-drainage resulting in woody shrub invasion and frequent fires (USFWS 1999b).

Lower East Coast Area (LEC 3). This area is located to the east of the L-31N, L-31W, and C-111 canals and the Levee divide. The area can be affected by seepage from the canals if water levels are too high. The target, from an agriculture viewpoint, is a low water table, one that is at least two feet below the ground surface. Peak stage indicators along the western edge of LEC 3 benefits from water levels that are either below the root zone or is at or above the root zone for relatively short periods of time. Nine cells are used to examine water levels. The percent of time above the root zone is zero for two of the cells, less than 13% of the time for four cells, less than 31% of the time for two cells, and less than 48% of the time for two cells. The cells are located from south to north as follows: R10-C25; R13-C25; R15-C26; R17-C27; R19-C28; R20-C28; R16-C29; R22-C29; and R24-C30.

8.5 SMA . This area is adjacent to but located on the western side of the L-31N Canal. The north and west boundary is the ENP Expansion area. The southern boundary of the area is the northern boundary of the Rocky Glades area. The area north and west of the 8.5 SMA experience very wet conditions the majority of the time except in very dry years. Average annual hydroperiod simulations indicate that the area experiences from as little as 0 to 60 days inundation on the eastern side to 240 to 300 days on the western side adjacent to the ENP. For a dry year (e.g. 1989) the simulation period shows more than half (eastern half) of the area

experiencing 0 to 60 days inundation while the other half (western half adjacent the ENP) experiences 60 to 180 days. For a wet year such as 1995 a small portion immediately adjacent to the L-31N Canal still experiences 0 to 60 days inundation. The remaining portion of the area experiences 180 to 365 days of inundation. Average annual ponding depths are very minor adjacent to the L-31N Canal but increase to 0.5 to 1.0 feet at the western side. In a dry month such as May, the eastern half of the area is minor depth (0.0 to 0.1 feet). The other half adjacent to the ENP is in the 0.5 to 1.0 feet class. For a wet month only a small percentage of the area on the eastern side remains in the minor depth class. Most of the area is 0.1 to 0.5 feet and 0.5 to 1.0 feet of ponding. Gage G-596 (R18-C26) is located on the eastern side of 8.5 SMA and the stage duration curve shows only 1 or 2% of the time when water levels are above ground level, which supports the hydroperiod and ponding data.

Biscayne Bay. Biscayne Bay is a shallow, tidal sound located near the extreme southeastern part of Florida. Biscayne Bay, its tributaries and Card Sound are designated by the state of Florida as aquatic preserves, while Card and Barnes Sounds are part of the Florida Keys National Marine Sanctuary. A significant portion of the central and southern portions of Biscayne Bay comprise Biscayne National Park.

Depending upon the flood stages reached, all C&SF Project canals in adjacent Dade County can carry floodwaters to Biscayne Bay. However, much of the time, discharges from project canals represent primarily runoff or seepage from within flood protected areas of the county. These flows originate in the extensive networks of secondary drainage canals and storm sewers that discharge into the project canals. Supplementing the complex system of project canals and secondary drainage systems are many hundreds of other stormwater drainage canals and storm sewer outfalls within Dade County that discharge freshwater directly into Biscayne Bay.

Florida Bay. Florida Bay and the Ten Thousand Islands comprise 1,500 square miles of the ENP. The bay is shallow, with an average depth of less than three feet. To the north is the Florida mainland and to the south lie the Florida Keys. Sheet flow across the marl prairies of the southern Everglades and 20 creek systems fed by Taylor Slough and the C-111 Canal provide direct inflow of freshwater to the bay. Surface water from SRS flows into Whitewater Bay and may also provide essential recharge for central and western Florida Bay. Exchange with Florida Bay occurs as this lower salinity water mass flows around Cape Sable into the western subregion of the bay.

Simulations were run for average annual overland flows toward Florida Bay across Craighead Basin, Taylor Slough, and the Eastern Panhandle (Appendix H). These are overland flows,

3.4 Water Supply

The Biscayne Aquifer underlies an area of approximately 4,000 square miles in Broward, Miami-Dade, Monroe, and Palm Beach Counties. This aquifer provides the only source of drinking water for approximately three million people who live primarily in urban areas from Homestead in Dade County northward to Boca Raton in Palm Beach County. Intensive pumping has lowered the water table in the vicinity of major well fields near Miami and Fort Lauderdale and has reversed the natural seaward direction of groundwater flow in some locations.

Supplemental irrigation is required for much of the region's agriculture, especially during the dry season and periods of drought. Farmers in the Everglades Agricultural Area (EAA) typically withdraw water from the network of canals to irrigate fields when water levels are excessively low during the dry season. Conversely, water is typically pumped from the fields into the canals for drainage when levels are excessively high during the wet season. Water supplies are typically at their lowest levels during the dry season and periods of drought when agricultural irrigation demands are the highest. Water shortage management policies can lead to restrictions on agricultural water usage that may have negative effects on crop production.

3.5 Water Quality

Water quality in the study area is significantly influenced by development. The C&SF project had led to significant changes in the landscape by opening large land tracts for urban development and agricultural uses, and by the construction of extensive drainage networks. Natural drainage patterns in the region have been disrupted by the extensive array of levees and canals such that nonpoint source (stormwater) runoff and point sources of pollution (wastewater discharges) are now entering the system in many areas. Several pollutants of concern have been identified and include metals, pesticides, nutrients, biologicals, physical pollutants, and other various industrial constituents. Specifically, phosphorus and pesticides are considered the most important contributers to water quality degradation in the area.

In the central Everglades, phosphorus concentrations entering the ENP were lower in 1997 (Walker 1998) than the interim and long term limits established by the 1992 Settlement Agreement in United States v. South Florida Water Management District, Case No. 88-1886-CIV-WMH (S.D.Fla.). While no significant trends in annual average mercury concentrations in water, sediment, or fish have been observed for the past five years, mercury concentrations in fish tissue were high enough to warrant a no-consumption advisory for largemouth bass throughout most of the eastern two thirds of the ENP, and a recommendation of limited consumption for the southeast corner of the ENP. The best water quality conditions in the ENP were found in the central Shark River Slough and along regions of the basin.

Some parts of Florida Bay have experienced a massive seagrass and mangrove die-off during the late 1980's and early 1990's that likely stems from a lack of circulation, high water temperatures, and increased levels of salinity. Reduction in flow into ENP has reduced freshwater flows to portions of Florida Bay, and the salinity of some portions of the bay has been recorded as high as 70.0 parts per thousand (ppt). The 1997 Everglades Annual Report

states that for 1997, the highest observed salinity levels occurred in Whipray Basin, and ranged from 40.6 ppt to 42.3 ppt (water conditions in the bay are considered hypersaline when salinity exceeds 35.0 ppt). Hypersaline conditions were observed throughout most of the western portion of the bay during the dry season; however, they decreased below hypersaline levels once freshwater inputs increased in June 1997.

Groundwater in south Florida consists of the surficial Biscayne Aquifer and the Floridan Aquifer. Both are critical to the ecology and economy of south Florida. The Biscayne Aquifer has been classified as a Sole Source Aquifer under the Federal Safe Drinking Water Act based on the aquifer's susceptibility to contamination and the fact that it is a principal source of drinking water. The Floridan Aquifer system is one of the most productive aquifers in the world and is a multi-use aquifer system. Where it contains freshwater, it is the principal source of water supply. In several places where the Floridan Aquifer contains saltwater, such as along the southeastern coast of Florida, treated sewage and industrial wastes are injected into it.

Because the Biscayne Aquifer is highly permeable and is at or near the land surface in many locations, it is readily susceptible to groundwater contamination. Major sources of contamination are saltwater intrusion and infiltration of contaminants carried in canal water. Additional sources include direct infiltration of contaminants, such as chemicals or pesticides applied to or spilled on the land, or fertilizer carried in surface runoff; leachate from landfills, septic tanks, sewage-plant treatment ponds; and wells used to dispose storm water runoff or industrial waste.

Water quality monitoring is currently being done in conjunction with the ISOP to determine phosphorus levels in waters entering the Everglades through a number of the water control structures.

3.6 Flood Control

Water management and flood control is achieved in south Florida through a variety of canals, levees, pumping stations, and control structures within the WCAs and ENP/South Dade Conveyance System (SDCS). The WCAs provide a detention reservoir for excess water from the EAA and parts of the east coast region, and for flood discharge from Lake Okeechobee to the sea. The WCAs provide levees to prevent Everglades floodwaters from inundating the east coast urban areas; provide a water supply for the east coast areas and ENP; improve water supply for east coast communities by recharging underground freshwater reservoirs; reduce seepage; ameliorate salt-water intrusion in coastal wellfields; and provide mixed quality habitat for fish and wildlife in the Everglades.

The regulation schedules contain instructions and guidance on how project spillways are to be operated to maintain water levels in the WCAs. The regulation schedules essentially represent the seasonal and monthly limits of storage which guides project regulation for the authorized purposes. The schedules vary from high stages in the late fall and winter to low stages at the beginning of the wet season. These regulation schedules must take into account various, and often conflicting, purposes.

The East Coast Canals are flood control and outlet works that extend from St. Lucie County southward through Martin, Palm Beach, and Broward Counties to Dade County. The East Coast Canal watersheds encompass the primary canals and water control structures located along the lower east coast of Florida and their hydrologic basins. The main design functions of the project canals and structures in the East Coast Canal area are to protect the adjacent coastal areas against flooding; store water in conservation areas west of the levees; control water elevations in adjacent areas; prevent salt-water intrusion and over drainage; provide freshwater to Biscayne Bay and provide for water conservation and public consumption. There are 40 independently operated canals, one levee, and 50 operating structures, consisting of 35 spillways, 14 culverts, and one pump station. The project works to prevent major flood damage. However, due to urbanization, the existing surface water management system now has to handle greater peak flows than in the past.

The ENP/South Dade Conveyance System provides a way to [illegible]

Dade County. This canal system was overlain on top of the existing flood control system. Many of these canals are used to remove water from interior areas to tidewater.

3.7 Wetlands

Wetlands are defined by the Corps (33 CFR 328.3) as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Activities that involve the discharge of dredged or fill material into jurisdictional wetlands and open waters are regulated under Section 404 of the Clean Water Act of 1977 [illegible]

nine months per year), and wet marl prairie communities (flooded less than six months per year) (USFWS 1999b). The freshwater wetlands of the Everglades eventually grade into intertidal mangrove wetlands and subtidal seagrass beds in the estuarine waters of Florida Bay.

Development and drainage over the last century have dramatically reduced the overall spatial extent of freshwater wetlands within the Everglades, with approximately half of the predrainage 1.2 million hectares of wetlands being converted for development and agriculture (Davis et al. 1997). Alteration of the normal flow of freshwater through the Everglades has also contributed to conversions between community types, invasion by exotic species, and a general loss of community diversity and heterogeneity. Recent vegetative trends in the ENP have included a substantial shift from the longer hydroperiod slough/open water marsh communities to shorter hydroperiod sawgrass marshes (Davis et al. 1997). In addition, invasion of sawgrass marshes and wet prairies by exotic woody species has led to the conversion of some marsh communities to forested wetlands (Gunderson 1997).

Vegetative communities of the WCAs have suffered from both over drainage and prolonged periods of inundation associated with the stabilization of water levels (USACE 1999a). Increased flooding and water depths in WCA 2A have resulted in the loss of wet prairie communities, drowning of tree islands, and loss of sawgrass marshes along slough edges. Major plant communities of WCA 2A now consist of remnant (drowned) tree islands, open water sloughs, and large expanses of sawgrass and sawgrass-cattail marshes. The increase in cattails in WCA 2A is attributed to increased nutrient loading associated with agricultural runoff. WCA 2B has suffered from lowered water levels resulting in heavy melaleuca infestations throughout the area. Increased deliveries of water to WCA 2B associated with drawdowns of WCA 2A in the 1980's has helped somewhat to slow the advance of melaleuca. Many areas of WCA 3A still contain relatively good wetland habitat consisting of a complex of tree islands, sawgrass marshes, wet prairies, and aquatic sloughs. However, the northern portion of WCA 3A has been over drained, resulting in increased fire frequency and the associated loss of tree islands; wet prairie; and aquatic slough habitat. Northern WCA 3A is currently dominated largely by monospecific sawgrass stands and lacks the diversity of communities that exists in southern WCA 3A. WCA 3B contains typical Everglades vegetation comprised of tree islands, wet prairies, sawgrass marshes, and aquatic sloughs.

The estuarine communities of Florida Bay have also been affected by upstream changes in freshwater flows through the Everglades. A reduction in freshwater inflows into Florida Bay and alterations of the normal salinity balance have affected mangrove community

Slough/Open Water Marsh

The slough/open water marsh community occurs in the lowest, wettest areas of the Everglades. This community is a complex of open water marshes containing emergent, floating aquatic, and submerged aquatic vegetation components. The emergent marsh vegetation is typically dominated by spikerushes (*Eleocharis cellulosa* and *E. elongata*), beakrushes (*Rhynchospora tracyi* and *R. inundata*), and maidencane (*Panicum hemitomon*). Common floating aquatic dominants include fragrant water lily (*Nymphaea odorata*), floating hearts (*Nymphoides aquatica*), and spatterdock (*Nuphar lutea*); and the submerged aquatic community is typically dominated by bladderwort (*Utricularia*

evergreen, broad-leaved hardwoods such as red bay (*Persea palustris*), sweetbay (*Magnolia virginiana*), dahoon holly (*Ilex cassine*), and pond apple (*Annona glabra*). Tree islands typically have a dense shrub layer that is dominated by cocoplum (*Chrysobalanus icaco*). Additional constituents of the shrub layer commonly include buttonbush (*Cephalanthus occidentalis*) and large leather fern (*Acrostichum danaeifolium*). Elevated areas on the upstream side of some tree islands may contain an upland, tropical hardwood hammock community dominated by species of West Indian origin (Gunderson 1997). Extended periods of flooding may result in tree mortality and conversion to a non-forested community. Portions of the WCAs have been flooded to the extent that many forested islands have lost all tropical hardwood hammock trees. Tree islands are considered an extremely important contributor to habitat heterogeneity and overall species diversity within the Everglades ecosystem (USFWS 1999b).

Mangroves

Mangrove communities are forested wetlands occurring in intertidal, low-wave-energy, estuarine and marine environments. Within the project area, extensive mangrove communities occur in the intertidal zone of Florida Bay. Mangrove forests have a dense canopy dominated by four species: red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*), and buttonwood (*Conocarpus erectus*). Mangrove communities occur within a range of salinities from 0 to 40 ppt. Florida Bay experiences salinities in excess of 40 ppt on a seasonal basis. Declines in freshwater flow through the Everglades have altered the salinity balance and species composition of mangrove communities within Florida Bay. Changes in freshwater flow can lead to an invasion by exotic species such as Australian pine (*Casuarina equisetifolia*) and Brazilian pepper (*Schinus terebinthifolius*).

Seagrass Beds

Seagrasses are submerged vascular plants that form dense rooted beds in shallow estuarine and marine environments. This community occurs in subtidal areas that experience moderate wave energy. Within the project area, extensive seagrass beds occur in Florida Bay. The most abundant seagrasses in south Florida are turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), and shoal grass (*Halodule wrightii*). Additional species include star grass (*Halophila engelmannii*), paddle grass (*Halophila decipiens*), and Johnson's seagrass (*Halophila johnsonii*). Widgeon grass may also occur in seagrass beds in areas of low salinity. Seagrasses have an optimum salinity range of 24 to 35 ppt, but can tolerate considerable short term salinity fluctuations. Large-scale seagrass die-off has occurred in Florida Bay since 1987, with over 18% of the total bay area affected. Suspected causes of seagrass mortality include high salinities and temperatures during the 1980s and long-term reductions of freshwater inflow to Florida Bay.

Rockland Pine Forest

Pine rocklands within the project area occur on the Miami Rock Ridge and extend into the Everglades as Long Pine Key. Pine rocklands occur on relatively flat terrain with moderately

to well-drained soils. Most sites are wet for only short periods following heavy rains (FNAI 1990). Limestone bedrock is close to the surface and the soils are typically shallow accumulations of sand, marl, and organic material. Pine rockland is an open, savanna-like community with a canopy of scattered south Florida slash pine (*Pinus elliottii* var.*densa*) and an open, low-stature understory. This is a fire-maintained community that requires regular burns to maintain the open shrub/herbaceous stratum and to control hardwood encroachment (Gunderson 1997). The overstory is comprised of scattered south Florida slash pines. The shrub layer is comprised of a diverse assemblage of tropical and temperate species. Common shrubs include cabbage palm (*Sabal palmetto*), coco-plum (*Chrysobalanus icaco*), myrsine (*Rapanea punctata*), saw palmetto (*Serenoa repens*), southern sumac (*Rhus copallinum*), strangler fig (*Ficus aurea*), swamp bay (*Persea palustris*), wax myrtle (*Myrica cerifera*), white indigo berry (*Randia aculeata*), and willow-bustic (*Sideroxylon salicifolium*). The herbaceous stratum is comprised of a very diverse assemblage of grasses, sedges, and forbs. Common herbaceous species include *Schizachyrium sanguineum*, *S. gracile*, *Andropogon longiberbis*, *A. glomeratus* var. *pumilis*, candyweed (*Polygala grandiflora*), creeping morning-glory (*Evolvulus sericeus*), pineland heliotrope (*Heliotropium polyphyllum*), rabbit bells (*Crotolaria rotundifolia*), and thistle (*Cirsium horridulum*) (USFWS 1999b). This community occurs on areas of relatively high elevation and consequently, has been subject to intense development pressure. In addition, fragmentation, fire suppression, invasion by exotic species, and a lowered water table have negatively affected the remaining tracts of pine rockland (USFWS 1999a).

Tropical Hardwood Hammock

Tropical hardwood hammocks occur on upland sites where limestone is near the surface. Tropical hardwood hammocks within the project area occur on the Miami Rock Ridge, along the northern shores of Florida Bay, and on elevated outcrops on the upstream side of tree islands. This community consists of a closed canopy forest dominated by a diverse assemblage of hardwood tree species, a relatively open shrub layer, and a sparse herbaceous stratum. This community is dominated by West Indian species and contains numerous species whose entire United States distribution is limited to tropical hammocks of south Florida. Common canopy species include gumbo-limbo (*Bursera simaruba*), paradise tree (*Simarouba glauca*), pigeon-plum (*Coccoloba diversifolia*), strangler fig (*Ficus aurea*), wild mastic (*Sideroxylon foetidissimum*), willow-bustic, live oak (*Quercus virginiana*), short-leaf fig

[redacted]

hammock trees.

3.9 Fish and Wildlife

Aquatic macroinvertebrates form a vital link between the algal and detrital food web base of freshwater wetlands and the fishes, amphibians, reptiles, and wading birds that feed upon them. Important macroinvertebrates of the freshwater aquatic community include crayfish (*Procambarus alleni*), riverine grass shrimp (*Palaemonetes paludosus*), amphipods (*Hyallela aztecus*), Florida apple snail (*Pomacea paludosa*), Seminole ramshorn (*Planorbella duryi*), and numerous species of aquatic insects (USACE 1999a).

Small freshwater marsh fishes are also important processors of algae, plankton, macrophytes, and macroinvertebrates. Marsh fishes provide an important food source for wading birds, amphibians, and reptiles. Common small freshwater marsh species include the golden topminnow (*Fundulus chrysotus*), least killifish (*Heterandria formosa*), Florida flagfish (*Jordenella floridae*), golden shiner (*Notemigonus crysoleucas*), sailfin molly (*Poecilia*

turtle (*Deirochelys reticularia*), Florida softshell turtle (*Trionys ferox*), water snake (*Natrix sipidon*), green water snake (*Natrix cyclopion*), mud snake (*Francia abacura*), and Florida cottonmouth (*Agkistrodon piscivorus*) (USACE 1999a).

The alligator was historically most abundant in peripheral Everglades marshes and freshwater mangrove habitats but is now most abundant in canals and the deeper slough habitats of the central Everglades. Drainage of peripheral wetlands and increasing salinity in mangrove wetlands as a result of decreased freshwater flows has limited the occurrence of alligators in these habitats (Mazzotti and Brandt 1997).

The freshwater wetlands of the Everglades are noted for their abundance and diversity of colonial wading birds. Common wading birds include the white ibis (*Eudocimus albus*), glossy ibis (*Plegadus falcenellus*), great egret (*Casmerodius albus*), great blue heron (*Ardea herodius*), little blue heron (*Egretta caerulea*), tricolored heron (*Egretta tricolor*), snowy egret (*Egretta thula*), green-backed heron (*Butorides striatus*), cattle egret (*Bubulcus ibis*), black-crowned night heron (*Nycticorax nycticorax*), yellow-crowned night heron (*Nycticorax violacea*), roseate spoonbill (*Ajaia ajaja*), and wood stork (*Mycteria americana*) (USACE 1999a).

Populations of breeding wading birds in the Everglades have decreased by approximately 90%, and the distribution of breeding birds has shifted away from the ENP into the WCAs (Bancroft et al. 1997). The WCAs support fewer numbers of breeding pairs with relatively lower reproductive success (USACE 1999a). Water management practices and wetland losses are believed to be the primary cause of the declines (Bancroft et al. 1997). Seasonal drydown and the associated concentration of prey in isolated pools is a critical component of wading bird ecology in the Everglades. Historically, wading birds bred primarily during the winter-spring dry season when prey became concentrated in these drying pools (Bancroft et al. 1997). Successful breeding requires a continuous source of prey within the foraging range of the nesting site (Hoffman et al. 1997). Changes in the availability of prey resulting from wetland losses and water management practices are believed to have contributed to the declines in breeding wading bird populations (Bancroft et al. 1997). Many foraging wading birds avoid dense, high sawgrass marshes and show a preference for slough/sawgrass marsh/ tree island mosaics that provide foraging habitat over a wider range of water stages (Hoffman et al. 1997). Recent vegetative trends have included substantial conversions of the wetter slough-open water marsh communities to dense sawgrass marshes and an apparent reduction in aquatic productivity (Davis et al. 1999). In addition, the important low salinity mangrove fish assemblage has been depleted as a result of changes in the salinity regime. Abandonment of the traditional breeding colony locations of the southern Everglades is largely attributed to declines in the freshwater marsh and mangrove food bases (USACE 1999a).

Mammals that are well-adapted to the aquatic and wetland conditions of the freshwater marsh complex include the rice rat (*Oryzomys palustris natator*), round-tailed muskrat, and river otter (*Lutra canadensis*). Additional mammals that may utilize freshwater wetlands on a temporary basis include the white-tailed deer (*Odocoileus virginianus*), Florida panther (*Puma concolor coryi*), bobcat (*Lynx rufus*), and racoon (*Procyon lotor*).

3.10 Protected Species

The USFWS (1999b) has determined that ten federally-listed species may occur within the area affected by the proposed action. The effects of the Experimental Program, Modified Water Deliveries Project, and C-111 Project on listed species and their critical habitat were summarized by the USFWS in a 1999 Biological Opinion (Appendix D). The Biological Opinion included a jeopardy opinion for the CSSS. The jeopardy opinion for the CSSS led to implementation of the current ISOP and the development of the proposed IOP. Detailed accounts of these species, including descriptions of their distribution; habitat; critical habitat; reproduction; foraging; movements, status and trends; and respective recovery plan objectives, are contained in Appendix D. Additional information regarding these species can be found in the *South Florida Multi-Species Recovery Plan* (USFWS 1999b). Table 4 provides a list of federally protected species addressed in the BO.

Table 4 Federally listed Species That May Occur Within the Project Area

Common Name	Scientific Name	Federal Status
CSSS*	*Ammodramus maritimus mirabilis*	Endangered
Snail Kite*	*Rostrahamus sociabilis plumbeus*	Endangered
Wood Stork	*Mycteria americana*	Endangered
American Crocodile*	*Crocodylus acutus*	Endangered
West Indian Manatee*	*Trichechus manatus*	Endangered
Florida Panther	*Felis concolor coryi*	Endangered
Red-cockaded Woodpecker	*Picoides borealis*	Endangered
Bald Eagle	*Haliaeetus leucocephalus*	Threatened
Eastern Indigo Snake	*Drymarchon corais couperi*	Threatened
Garber's Spurge	*Euphorbia garberi*	Threatened

*Designated critical habitat

3.11 Air Quality

The existing air quality within south Florida is considered, and the region is in attainment for all National Ambient Air Quality Standards. Primary sources of air pollution in south Florida,

3.13 Aesthetics

The visual characteristics of south Florida can be described according to the three dominant land use categories (natural areas, agricultural lands, and urban areas). The natural areas consist of a variety of upland and wetland ecosystems, including lakes, ponds, vast expanses of marsh and wet prairie, with varying vegetative components.. Uplands are often dominated by pine, although other sub-tropical and tropical hardwoods such as fig, gumbo limbo, and cypress occur within their ecotone. Overall, the land is extremely flat, with few natural topographic features. Much of the visible topographic features are man-made, including canals and levees. Additional man-made features include pump stations, navigation locks, secondary and primary roads, highways, electrical wires, communication towers, occasional buildings, and borrow pits.

3.14 Recreation

Recreational opportunities are abundant in south Florida. In addition to the marine based recreation activities of the urbanized east coast, the ENP and WCAs provide high quality boating, fishing, hiking, and nature interpretation activities which annually attract many recreational visitors.

The ENP has been designated a World Heritage Site, an International Biosphere Reserve, and a Wetland of National Significance. In addition, 86% of the ENP is designated Wilderness under the Wilderness Act of 1964. The State of Florida has designated ENP an Outstanding Florida Water.

3.15 Land Use

The existing land use within the project boundaries varies widely from agricultural to high-density multi-family and industrial urban uses. A large portion of south Florida remains natural, although much of it is disturbed land. The dominant natural features are the federally protected ENP, Biscayne National Park, Big Cypress National Preserve, and the state-protected WCAs. Generally, urban development is concentrated along the lower east coast from Palm Beach County to Dade County.

The lower east coast extends approximately 100 miles through the coastal portions of Palm Beach, Broward, and Dade Counties. As the most densely populated subregion in the state, the lower east coast is home to one third of the state's population, more than 4.5 million people. The subregion is primarily an urban megalopolis, but it also contains substantial agricultural acreage, particularly in southwestern Dade County (90,000 acres). Rapid population growth and land development practices have resulted in notable western urban sprawl; the predominant land use is single-family residential. The once significant rural population in the western areas of Broward County has practically disappeared, resulting in an urbanized makeup in population.

The majority of land within the area potentially impacted by the proposed project is within the ENP and is publicly owned. However, a number of privately owned parcels still exist within this region, and purchase of these parcels is currently underway. It is anticipated that most of these properties will be in public ownership prior to project implementation.

3.16 Socioeconomics

Florida's economy is characterized by strong wholesale and retail trade, government, and service sectors. The economy of south Florida is based on services, agriculture, and tourism. Florida's warm weather and extensive coastline attract vacationers and other visitors and help make the state a significant retirement destination. The three counties that comprise the lower east coast (Palm Beach, Broward, and Dade) are heavily populated, and it is estimated that

farmers generally attempt to hold the water table at a depth of 20 inches for sugarcane. Farmers typically withdraw water from the network of EAA canals to irrigate fields when water levels are excessively low during the dry season. Conversely, water is typically pumped from the fields into the canals for drainage when levels are excessively high during the wet season. The EAA typically receives water supplies from Lake Okeechobee and discharges excess drainage water to the WCAs.

The LEC area contains over 100,000 acres of cultivated lands in Palm Beach, Broward, and Dade Counties. This area is dominated by small farms averaging less than 50 acres. LEC agriculture has a total market value of nearly $400 million and provides over 18,000 jobs. In contrast to the EAA, soils of the LEC are generally sandy. Consequently, irrigation is primarily applied to the surface, and subsidence is not a significant problem. The primary crops grown in the LEC include vegetables, tropical fruits, and nursery plants. The LEC depends heavily on unconfined surface aquifers for its agricultural water supply. Water management conflicts exist between the water needs of ENP and flood control for the adjacent agricultural lands. High rates of seepage from the ENP towards the east tend to dry out the ENP, while raising groundwater levels and compromising flood control on agricultural lands.

3.18 Hazardous, Toxic, and Radioactive Materials

A preliminary Phase I Hazardous, Toxic, and Radioactive Waste (HTRW) assessment was conducted in August 1998 to address the potential for occurrence of HTRW on lands within the full scope of the C&SF project in the study area (USACE 1999a). The assessment included a project review, review of site literature and aerial photography, database search, review of available records, and assessment of specific indicators such as landfills, dumps, disposal areas, aboveground and underground storage tanks, vats, containers of unidentified

By the early 1800's, the migrant Native American population of Florida had grown to about 5,000. The Miccosukees and Seminoles migrated to south Florida and established themselves in the Everglades, the Big Cypress Swamp, and the Ten Thousand Islands. Most of the people lived on upland tree islands (hammocks), and used dugout canoes for transportation, hunting, and trading. Dwellings, called chickees, were constructed of cypress logs and palm fronds. The traditional lifestyle endured for the remainder of the century and still endures to some extent today.

While documented prehistoric or historic sites within the project area are few, the numerous tree islands located throughout the ENP have potential for future historic discovery. Archeological deposits may be buried as much as 2 meters below the surface. Human burials are occasionally found in the area within shell middens or within isolated solution holes.